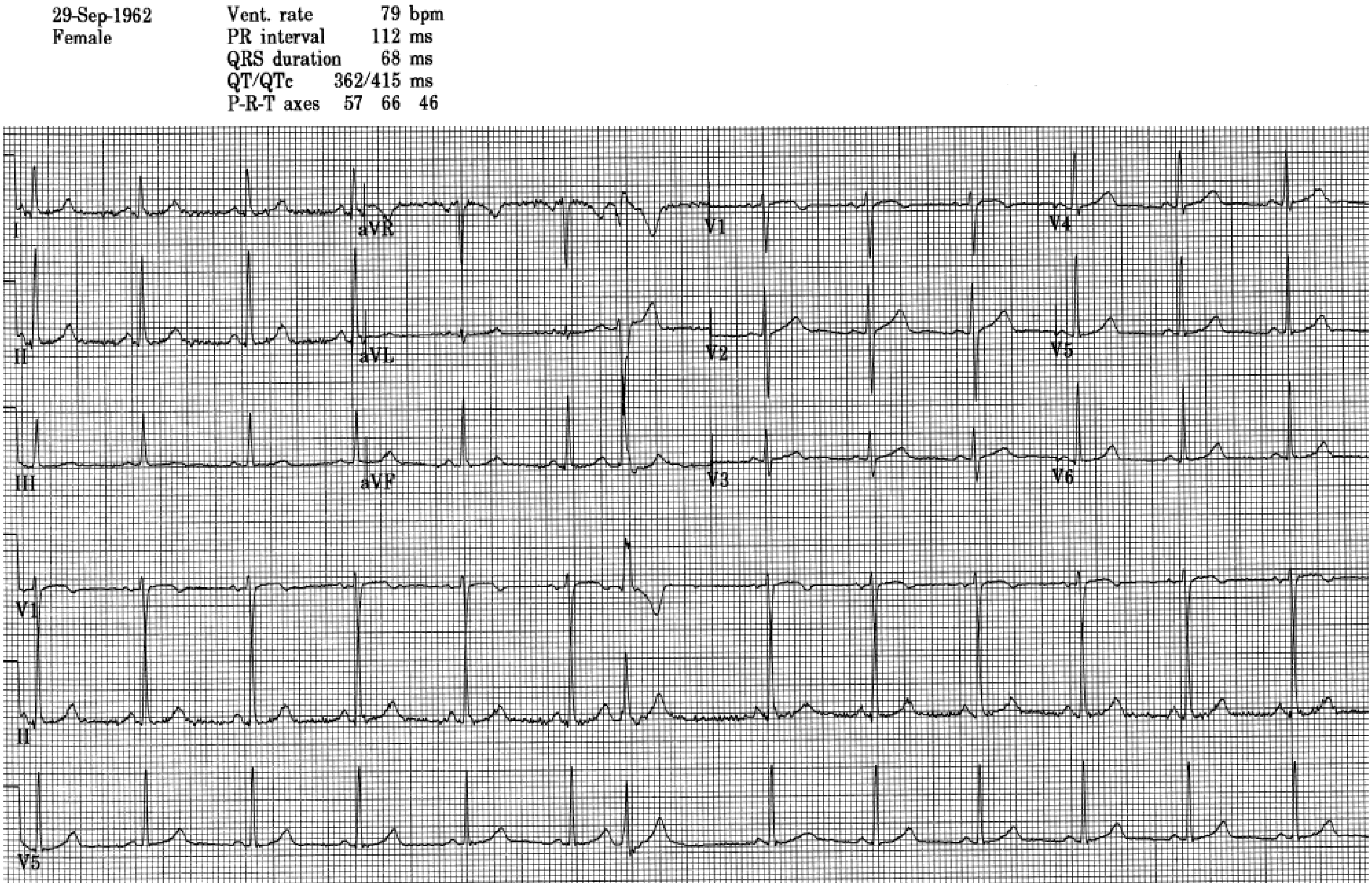
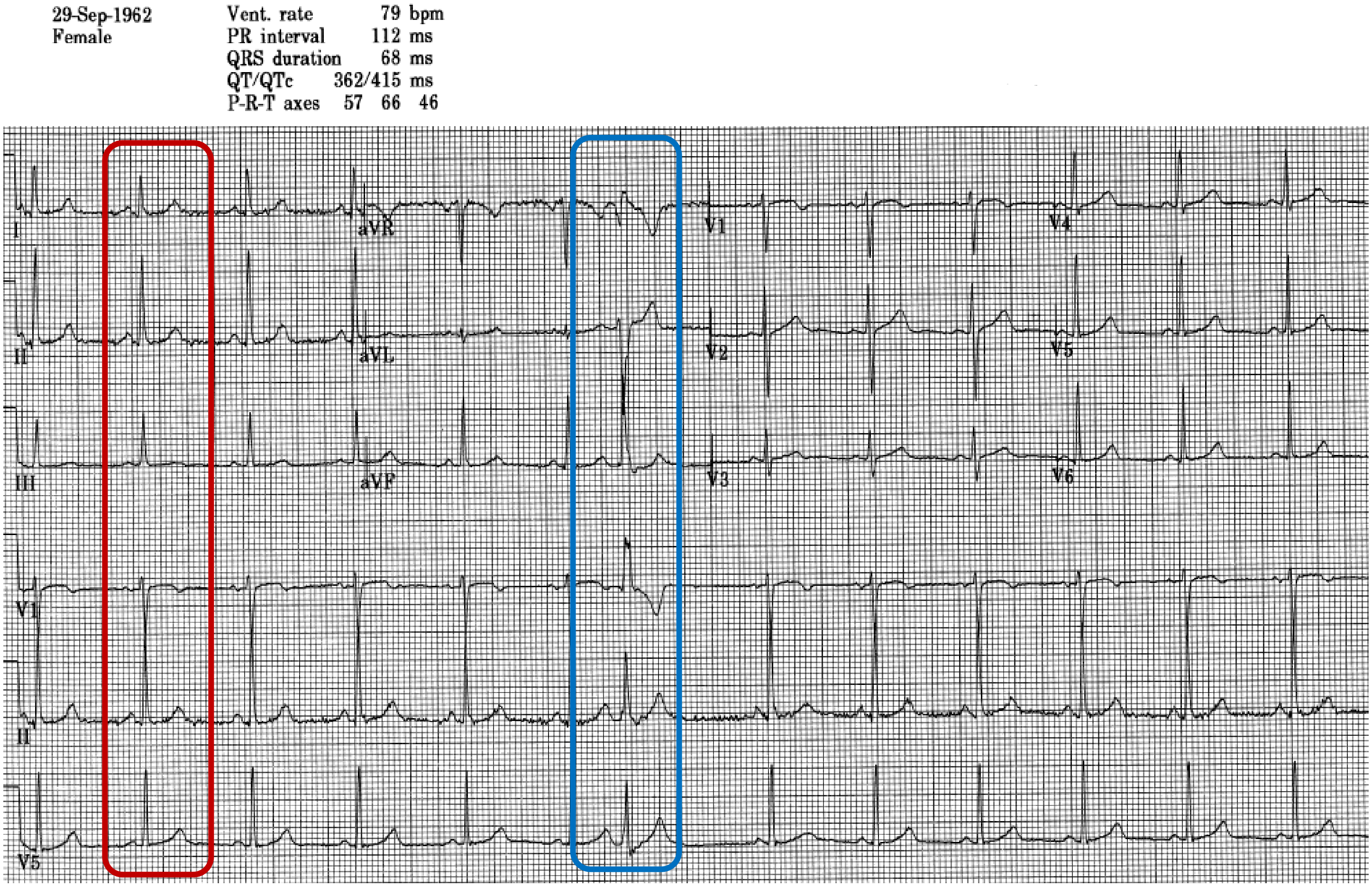
Some Tips and Tricks (Mostly for Newbies)



I always enjoyed getting a few "tips and tricks" from other physicians throughout the years, so I'm going to pass on a few to those who are new to 12-lead ECG interpretation.

One of the things that I want you to understand first of all, is that the interpretation of 12-lead ECGs deals more with *likelihoods* than *iron-clad diagnoses*. There are often several possible interpretations of an electrocardiographic event, and our job is to try to decide which interpretation – given any other facts brought to our attention (patient history, previous ECGs, physical exam) – is the most plausible.

This looks like a basically normal 12-lead ECG and – *basically* – it is! However, the first thing to catch our eye here is an irregularity in the rhythm that occurs in the middle of this 10-second tracing. If we were to see only the Lead II and Lead V5 rhythm strips, we might prematurely think that this is either a *premature atrial complex* (PAC) or a *premature junctional complex* (PJC) because those QRS intervals (or complexes) look *narrow* and *normal*. The premature beat may very well be a PAC or PJC with aberrant conduction – *but we don't know that yet*.

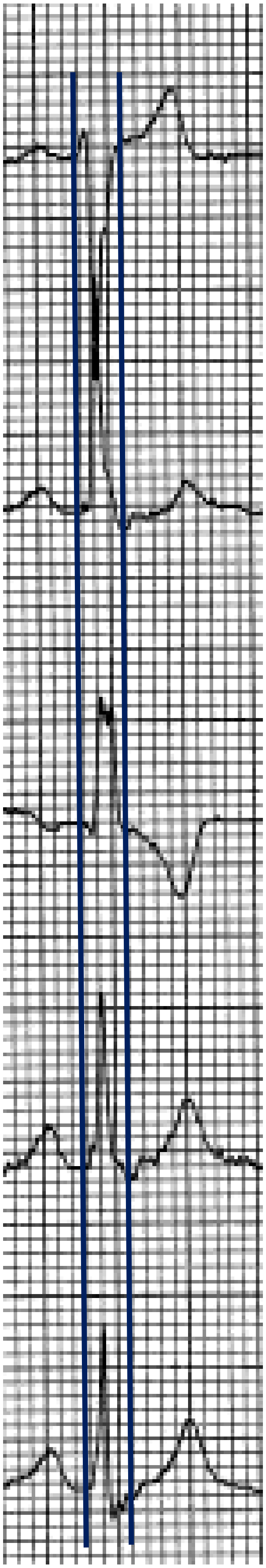


Here is your **FIRST TIP**: ***Ventricular ectopy*** (i.e., a PVC) generally looks wider and more bizarre than ***aberrant conduction*** (i.e., bundle branch block). Of course, there can be exceptions, but it's *generally* true.

This 12-lead ECG has six (6) ***channels***. Each *row* represents one *channel*. A three (3) channel ECG would have no rhythm strips – just the 12 leads. A one (1) channel ECG would just be a long strip of ECG paper about 2 inches in width with each lead recorded individually – one after another. The long strip would then be rolled up so that Lead I was the first lead to be seen. Sometimes there are 12 channel ECGs in which each lead is its own rhythm strip.

Now for the **SECOND TIP**: All six channels are recorded *simultaneously* and that is a fact that can be used to your advantage! All the P-QRS-T complexes within the red rectangle are the ***same beat!*** The same goes for all the beats within the blue rectangle. You can see how the cardiac impulse is viewed by the different leads.

Now let's put this tip to use (**FIRST TRICK**): Look at the beats in the blue rectangle. I'm going to enlarge the beats in the bottom five channels on the next page…



What we see here is that the QRS complexes are all at least 120 msec (0.12 sec) in duration. (*Width* on an ECG is measured in milliseconds, and that's *duration.*)

Well, we want to know what kind of premature beat this is: is it a PVC, a PAC or a PJC. Whatever it is, we can see that it's at least 120 msec in duration. But that could *still* be *any* of the three types of premature beats mentioned. PVCs are usually longer than 120 msec in duration, but you *will* come across some that are *exactly 120 msec* occasionally.

When we say that a beat is *aberrantly conducted*, we mean that it arrived at the division of the His bundle into the right and left bundle branches and found *one* of the bundle branches still refractory from the previous beat. Therefore, it is blocked in that bundle and so it travels down the other bundle branch. So, *aberrant conduction is really a bundle branch block*. Because the right bundle branch has a slightly longer refractoriness than the left bundle branch, *aberrant conduction usually takes the form of a right bundle branch block*. Not *always*… but *usually*!

The premature beat in Lead aVL (the top beat in this snippet on the left) is going to help us a lot because the *onset* and *termination* of the QRS are fairly obvious. So, I am going to drop two vertical, dark blue lines down through the *onset* of the QRS in aVL and its *termination*.

Here is the **THIRD TIP**: Often what you THINK is *baseline,* or *PR segment,* or *ST segment* is actually part of the ***QRS complex***! The other QRS complexes ***include*** what appears to be PR segment or ST segment. **FIRST TRICK** again: Always use the fact that *the channels are recorded simultaneously* to better understand what is – and what is NOT – the QRS complex!

Looking at all the leads that manifested this premature beat, we see that most of the premature beats are similar to the regular, sinus conducted beats. Certainly not exactly like the regular beats, but very similar in morphology. ***Except for Lead V1*** (third beat from the top)***!*** It is *totally* different. The ***morphology*** *of the QRS* is different, the ***polarity of the QRS*** is different and the ***morphology of the T wave*** is different. And the QRS morphology appears to be of a right-bundle branch block type.

All this points to a premature beat – likely a PJC that has conducted to the ventricles with a right bundle branch block aberrancy. If this were a PVC, I would have expected more characteristic changes in the other leads.

In this snippet on the left, the top line is Lead aVF and the bottom line is Lead II – both are inferior leads. It is very fortuitous that we have a normal sinus beat immediately adjacent to the premature beat – so let's compare them.

In aVF, if we look in the circled area of the normal sinus beat, we do not see any deflection dipping below the baseline. However, in the premature beat, the arrow is pointing to a tiny s wave. Actually, it's called a ***pseudo-s wave***. We usually see pseudo-s waves in AV nodal reentrant tachycardias, but we can see them in PJCs as well. It is NOT really an s wave – ***it's an inverted retrograde P' wave***.

As you recall (I hope!), a premature junctional complex (PJC) can have a retrograde P' wave appear *before*, *during* or *after* the QRS interval (or complex). In this case, it's sort of a combination of the last two possibilities: after the QRS – but *just barely*! If we look at Lead II (bottom line), we see the same thing.

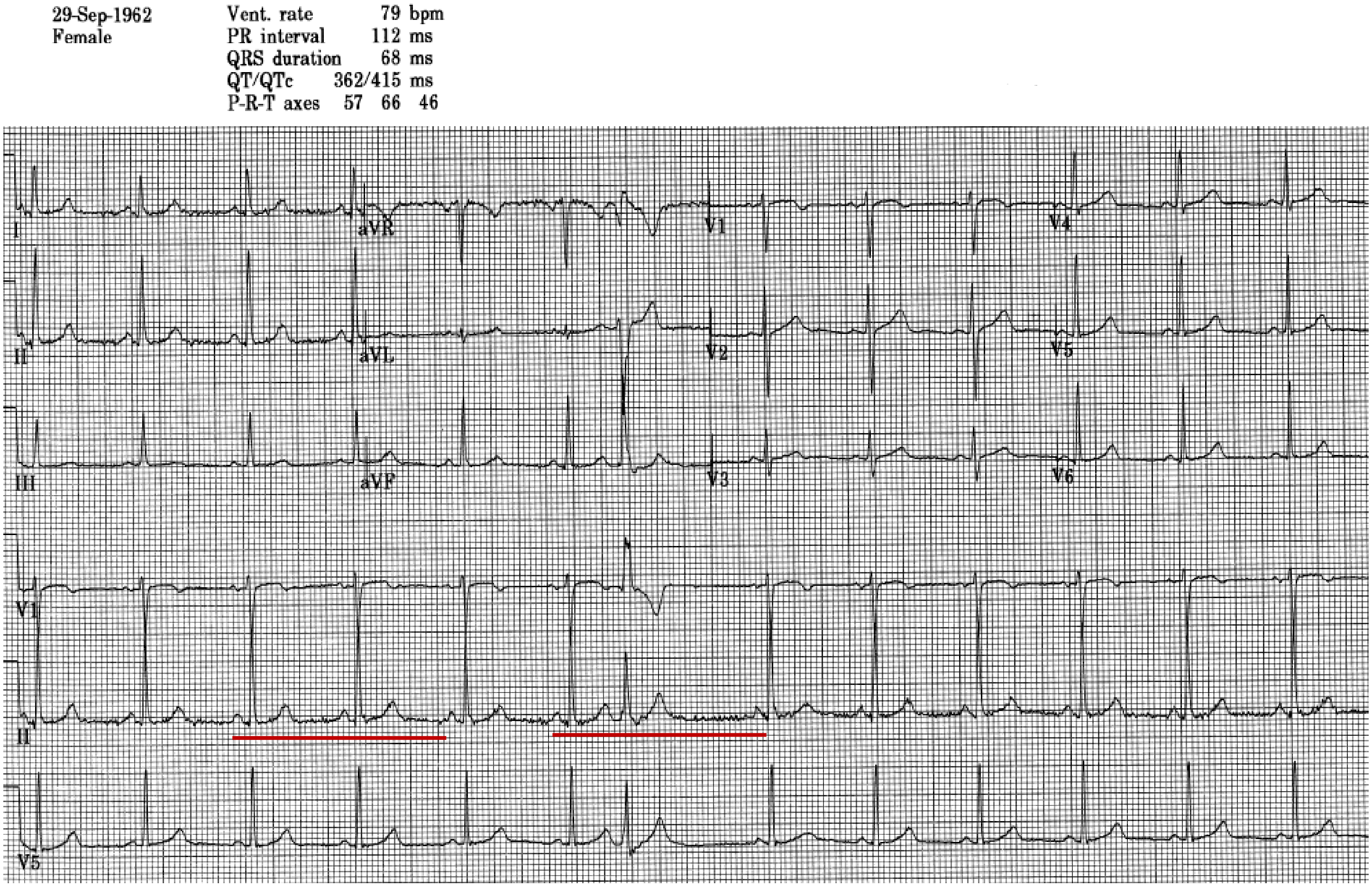
This premature beat is definitely a junctional ectopic beat. Now, the question is…

Why is there such a *long pause* after the premature beat? Well, the pause is due – at least in part – to a *compensatory* or a *non-compensatory* pause.

In the "old days," we assumed that a PVC resulted in a compensatory pause most of the time and a PAC was almost always followed by a non-compensatory pause. As far as a PJC was concerned, who knew? Back then (and still even today), PJCs were not as frequent as PACs or PVCs.

A pause is ***compensatory*** when the ectopic beat ***fails to reach the sinus node*** and thus ***has no effect on the sinus rate or rhythm***. The sinus node continues its output all through the ectopic beat. Sometimes a sinus P wave can't be seen because it is obscured by the ectopic beat, but it *is* there – *occurring right on time*, as are all the following beats. If you measure from the onset of the sinus P wave preceding the ectopic beat to the onset of the first sinus P wave after the ectopic beat, the duration will be the equivalent of two regular P-P intervals.

A pause is ***non-compensatory*** when the ectopic beat ***manages to reach the sinus node, discharge it, and reset it*** so that it starts its spontaneous depolarization cycle once again. There is a duration of time between when the sinus node was discharged and reset (reset

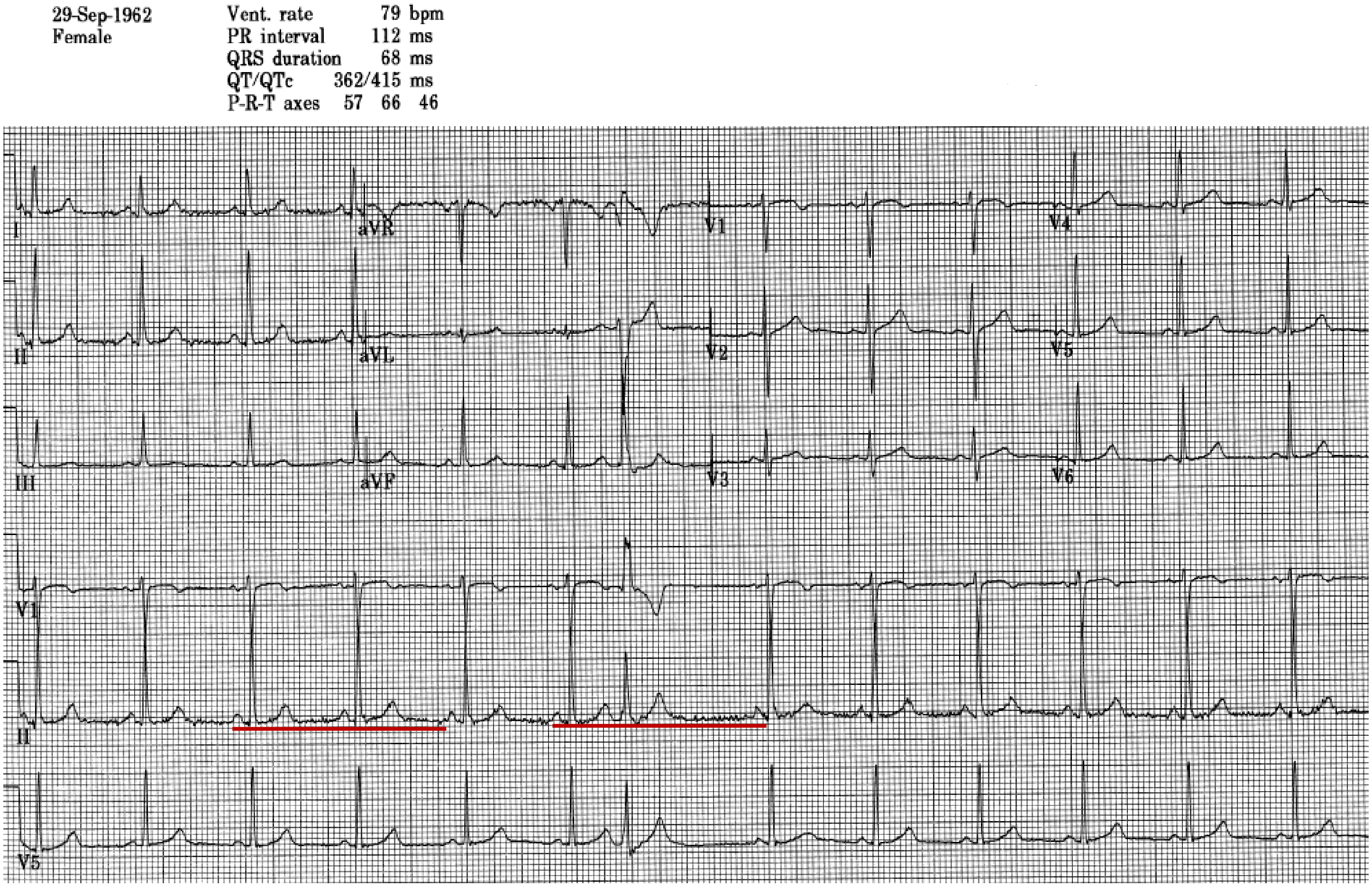


refers to the sinus node beginning its depolarization once again) that must be added on to the P-P interval. Usually, this will result in ***a pause that is less than two regular P-P intervals***. Sometimes, in the process of being discharged, the sinus node finds itself more repolarized than usual (*hyperpolarization*) and it takes a lot longer for it to return to its usual level of resting membrane potential to begin its depolarization again. This can occasionally take ***longer than two normal P-P intervals***. So, *a non-compensatory pause can be shorter than two regular P-P intervals, or it can be longer*. On rare occasions – *and strictly through coincidence* – a non-compensatory pause can be *exactly* two regular P-P intervals – just like a compensatory pause. Good luck with that!

I measured two sinus P-P intervals ***before the pause***.

FOURTH TIP: When you measure the duration between deflections on an ECG, always try to measure from the *onset* of the first deflection to the *onset* of the second deflection. Granted, sometimes the onset of a deflection is not very clear and so you must measure between peaks or nadirs. But always *attempt* to measure from the onset (there's a reason for this!).

FIFTH TIP: When you are measuring a *compensatory* or *non-compensatory pause*, you are measuring **P-P intervals** – ***NOT*** R-R intervals. Compensatory and non-compensatory pauses are



concerned with effects on the sinus node and its production of P waves. ***Neither pause has anything to do with QRS complexes***. Yeah, I KNOW that there are a number of blogs and websites that say to measure the R-R interval ***AND THEY ARE WRONG, WRONG, WRONG!*** If you wanted to know if your garage is long enough for your new Lamborghini to fit, why would you go measure the distance between manhole covers on your street? Just as the distance between manhole covers has nothing whatsoever to do with the size of your garage – ***R-R intervals have nothing whatsoever to do with compensatory and non-compensatory pauses!***

As you can see, the red lines are equal to two normal P-P intervals (measured *before* the pause). It is important that you try to measure the "normal" P-P intervals before the pause – you'll see why in a moment. We see that the P-P interval surrounding the post-ectopic pause is *slightly less* than two normal P-P intervals... *but just slightly*. Is this because we are measuring sinus P waves and we all know (or should know) that sinus rhythm often varies a bit, even when we call it "regular?" Or could this actually represent a *non-compensatory pause*? Any thoughts about how we can decide?

SECOND TRICK: OK... here's why I said it is very important to measure the "normal" P-P intervals *before* the pause: if you measure a single P-P interval *before* the pause and then measure the P-P interval *after* the pause, you will see that the P-P intervals *after* the pause have changed. *They are shorter!* The sinus rate *suddenly increased slightly* with the resumption of sinus rhythm *immediately following the pause*. Why did that happen?

It happened because that retrograde P′ wave managed to enter the sinus node and reset it. *But it did even more*: it resulted in a change from one pacemaker within the sinus node to another faster pacemaker higher up in the node. The sinus node is NOT a single pacemaking cell. There are many, many pacemaking cells in the sinus node and the pacemaking function can shift from one to another. This happens – *and not infrequently* – when the sinus node is breached by a retrograde P′. And this is what happened with that premature junctional complex. That's how I knew that this was a *premature junctional complex* that resulted in *resetting the sinus node* and creating a *non-compensatory pause*.

Well, I hope you learned something from this post.

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